

NIST Trace Explosive Vapor Preconcentrator (EVAP) Test Facility

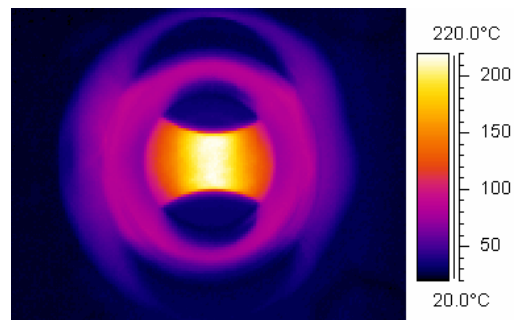
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Vision: To improve our Nation's ability to counter terrorism threats by improving the sensitivity of trace explosive detection at airports and other public venues.

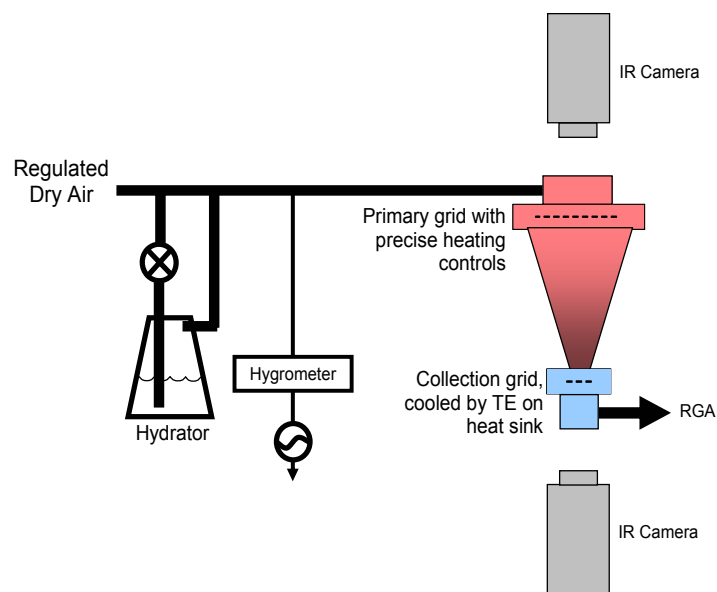
Purpose: To establish standards for testing chemical processing technologies that preconcentrate the vapors of RDX, HMX, PETN, TNT, and other explosives.

Context: The standard test system will be used to compare existing methods and materials used in trace explosive chemical preconcentrators, and to provide comprehensive benchmarks for future improvements to preconcentrator technologies.

This project is part of a larger effort in the NIST Surface and Microanalysis Science Division focused on strengthening the chemical metrology system that supports the widespread operational deployment of trace explosive detectors needed by first responders and security screeners. This effort is funded by the U.S. Department of Homeland Security (Office of Domestic Preparedness) through the NIST Office of Law Enforcement Standards. Stakeholders include portal/detector manufacturers such as GE Ion Track and Smiths Detection, and the U.S. Transportation Security Agency, which has a broad and immediate mandate to advance and deploy explosive detectors at airports to screen passengers and luggage.



Temporal temperature distribution of a metal substrate, heated resistively to vaporize explosive particles in the EVAP, is revealed by infra-red thermometry. Downstream, explosive vapors are recaptured on a cooled collection grid (not shown).

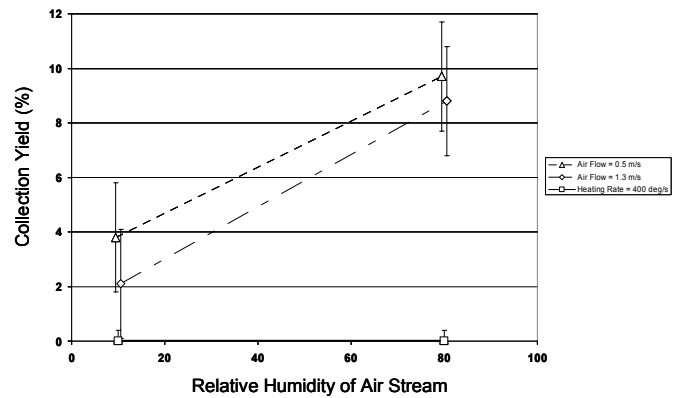


Schematic of EVAP with peripherals that include a regulated air flow controller, hydrator, and hygrometer, through which air of desired humidity (<10% to 90% RH) and flow rate (<1 to 20 LPM) may be supplied. Resistive heating of the primary grid is performed with an operational power supply, where the output voltage and amperage may be adjusted to give the desired heating rate (1 °C/s to 500 °C/s). The EVAP was designed so that the two grids could be monitored by infra-red (IR) thermometry through BaF₂ (IR-transparent) windows. Other components include a thermoelectric (TE) Peltier cooling module and an interface for future residual gas analysis – i.e., measurements of explosive vapors in the air stream that were not condensed on the collection grid.

Major Accomplishments: The major technical challenge involved the design and fabrication of a robust system that integrated the ability to monitor multiple aspects of performance, allowed flexibility of configuration, and was fairly easy to operate. Demonstration of capabilities involved determining the collection efficiency of the EVAP with respect to explosive type, heating rate, and airstream velocity and humidity. These four variables all proved to be significant. Under the operational ranges tested, RDX – but not PETN or TNT – was collected. Collection was enhanced at low heating rates, low air flow rates, and high airstream humidity levels.

Future Plans: Morphology and chemical derivation of collector surfaces will be explored, as well as over 25 operational variables that may govern the explosive collection efficiency of vapor preconcentrators. We have designed fractional factorial experiments to explore the significance and interrelationships among these variables. In FY05, measurements and multivariate analysis will be performed to characterize comprehensively the EVAP performance.

Program: Forensics and Homeland Security



Results for vapor collection of RDX on 316L stainless steel mesh at 70 °C. Collection was enhanced by slow heating rate (20 deg/s), low air flow (0.5 m/s face velocity on collector), and high water vapor content of air stream (relative humidity = 80 % at 20 °C). Error bars are standard uncertainties based on reproducibility of replicated ion mobility spectrometry measurements.